

Surface Energy Balance

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Overview

- Emissivity Observations with ASTER
 - Effect on longwave energy balance
 - Spectral emissivity: boundary condition for TIR temperature & humidity sounders
- Determination of Surface Heat Fluxes
 - Use of ASTER data in models



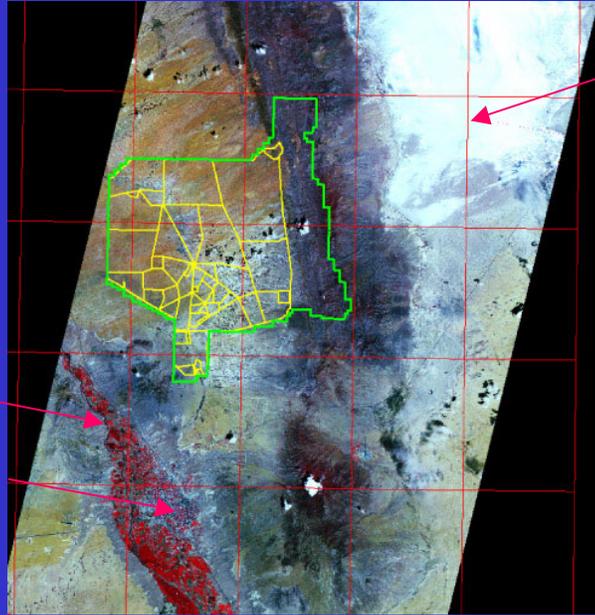
ASTER VNIR Imagery Jornada

May 12, 2001
12:06 MDT
60x90 km
IFOV = 15 m
10 Min Grid

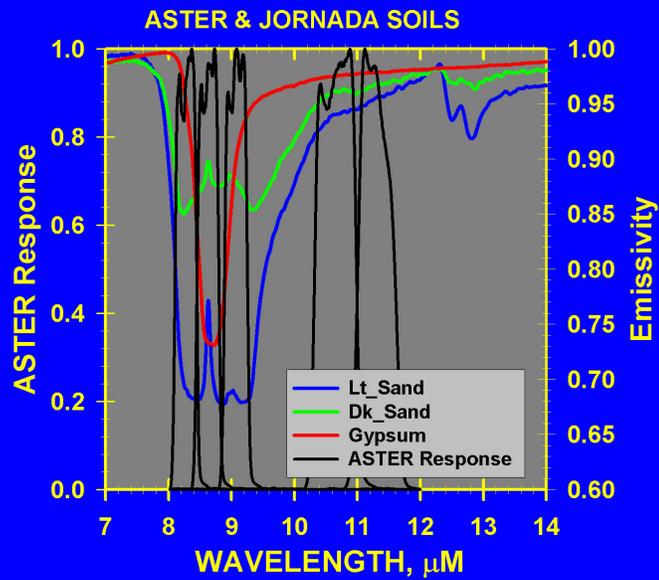
Rio Grande

Las Cruces, NM

White Sands Nat'l Monument



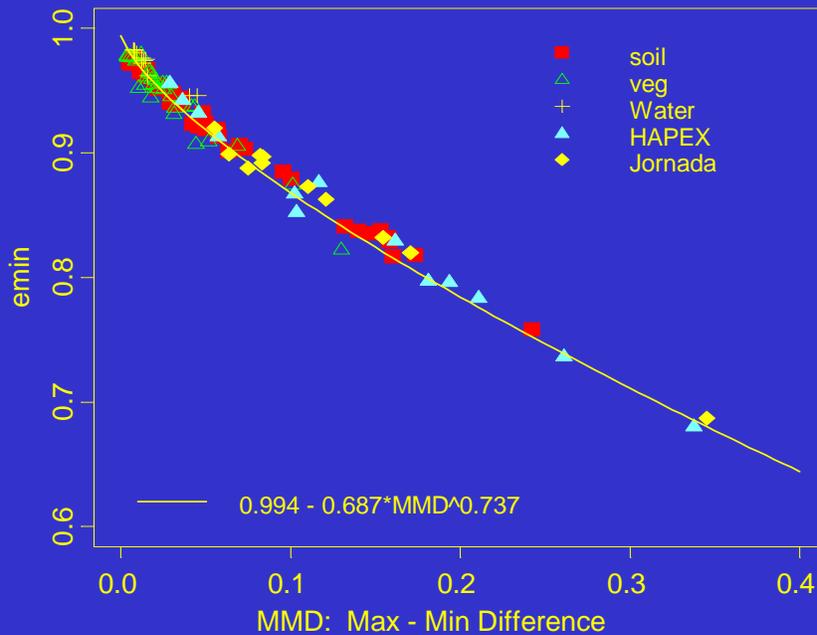
ASTER TIR Response



TES

Temperature - Emissivity Separation

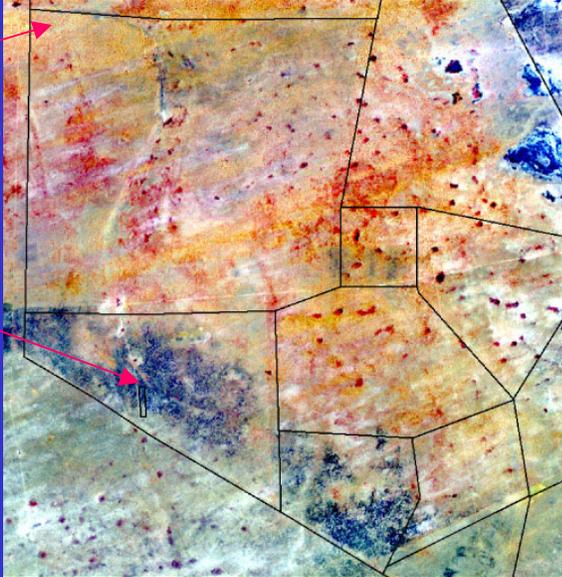
- ▶ Requires Multispectral TIR data
 - * Minimum of 4 channels
 - * Start with Emissivity Normalization
- ▶ Empirical relation between ϵ_{\min} and $\Delta\epsilon$
- ▶ Developed for use with ASTER TIR data
 - ▶ $\beta_i = \epsilon_i / \langle \epsilon_i \rangle$
 - ▶ $MMD = \beta_{\max} - \beta_{\min}$



ASTER VNIR Imagery: Test Sites

Mesquite Site
Lower emissivity
Degraded Condition

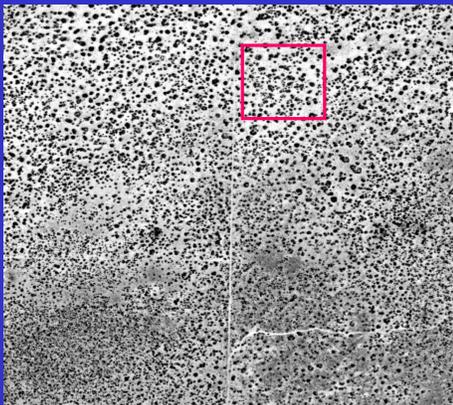
Grass Site
Higher emissivity
Original condition



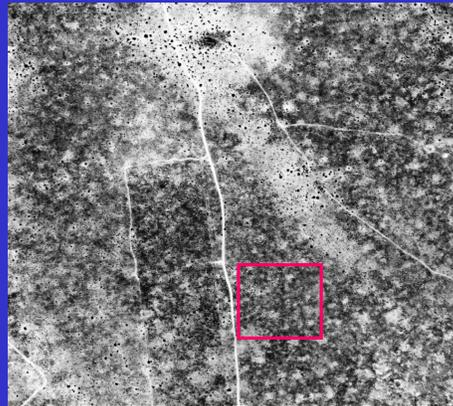
Ikonos Imagery - Jornada

July 20, 2000 - 1 x 1 km - IFOV = 1m

Mesquite Site - Low Emissivity



Grass Site - High Emissivity



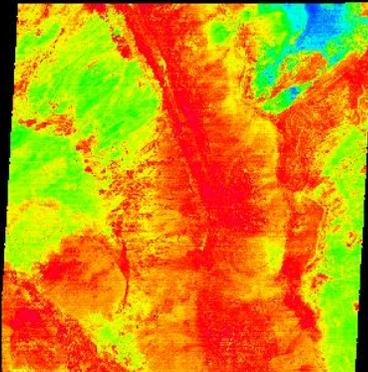
ASTER 2x2 Pixel Box



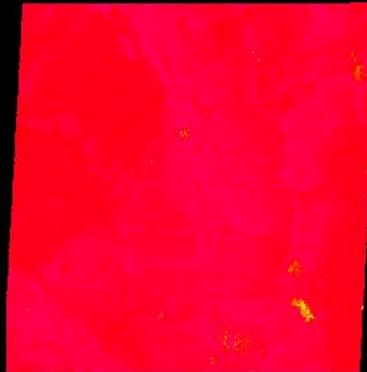
ASTER Emissivity Maps 11 & 13

ASTER EMISSIVITIES - Jornada Site
5/12/2001 - 1806 GMT

Channel 11



Channel 13



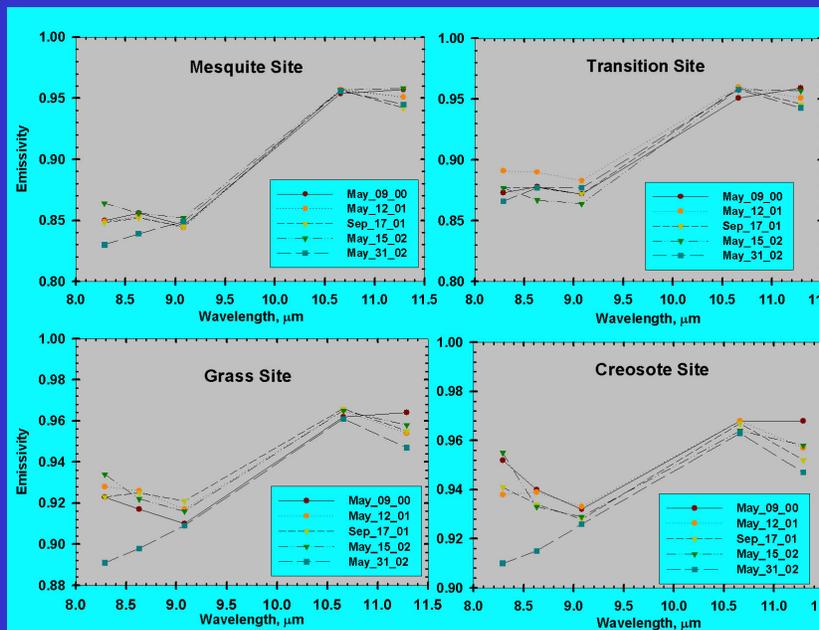
0.7

0.8

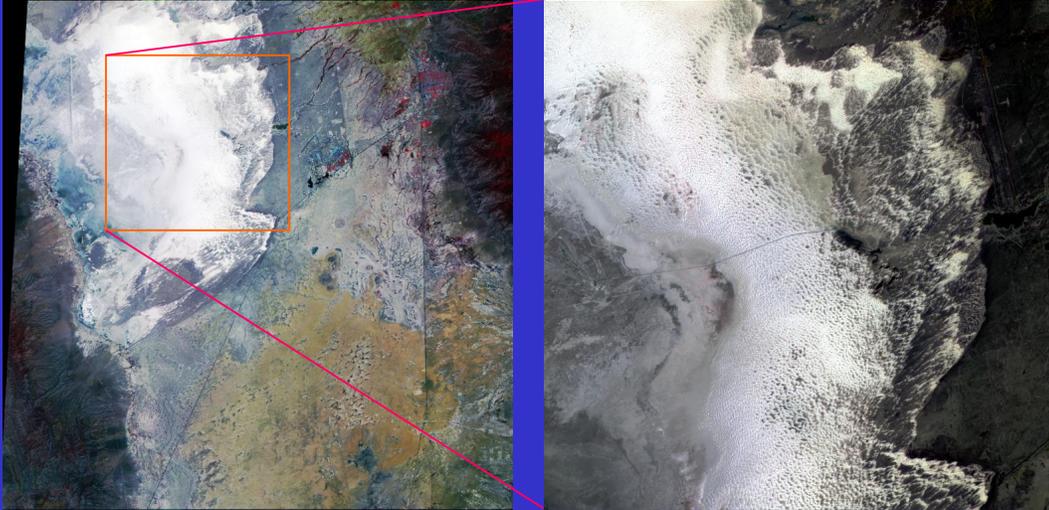
0.9

USDA - HYDROLOGY LAB

ASTER Jornada Emissivity Results



ASTER VNIR White Sands May 21, 2001



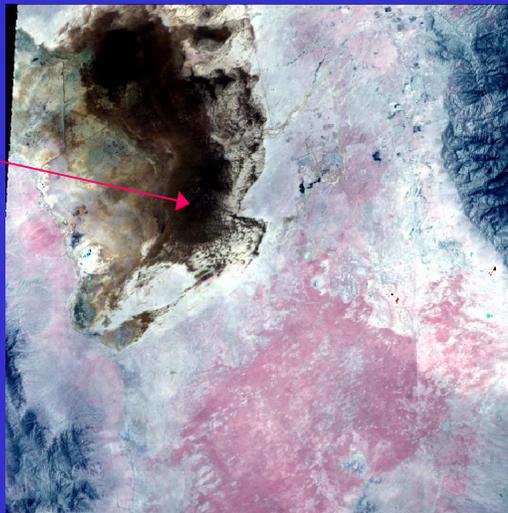
63 X 63 km

22 X 22 km

ASTER TIR White Sands May 21, 2001

Ground
Measurement
Site

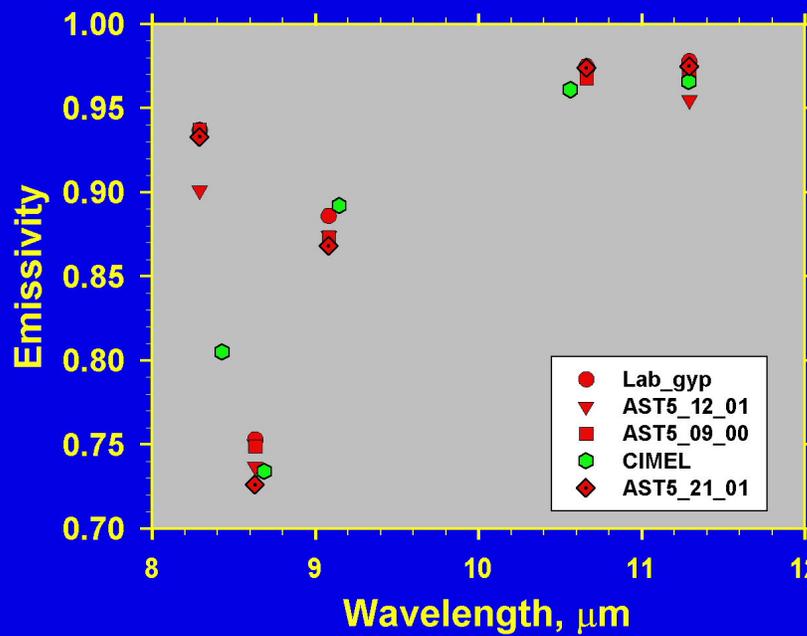
Red > 10.7 μm
Grn > 9.1 μm
Blu > 8.6 μm



CIMEL at White Sands

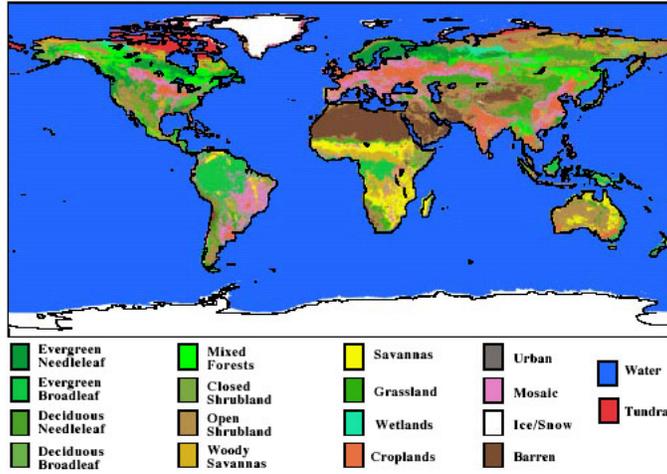


ASTER - Gypsum - White Sands



IGBP Land Use Map

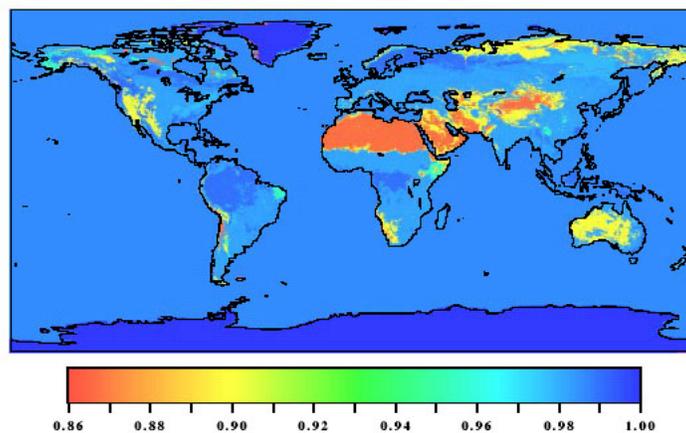
Figure 3. Surface Types on 10' grid.



From Wilber et al., 1999 NASA TP-1999-209362

Window Emissivity Derived from Land Use

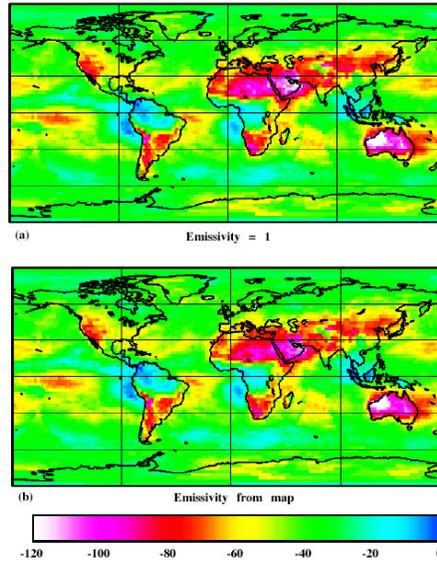
Figure 6. CERES Window (8-12 μm) Surface Emissivity on 10' grid



From Wilber et al., 1999 NASA TP-1999-209362

Effect of Emissivity on Net Longwave (NLW) Radiation Flux

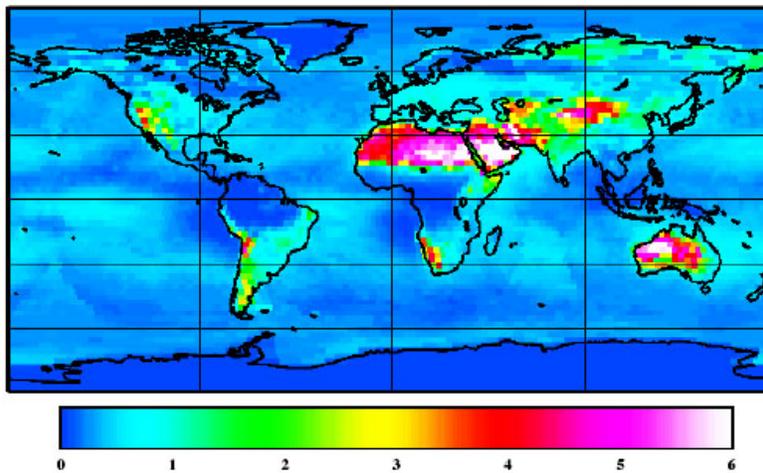
Figure 8. Surface Net Longwave Flux (Wm^{-2}) for October 1986.



From Wilber et al., 1999 NASA TP-1999-209362

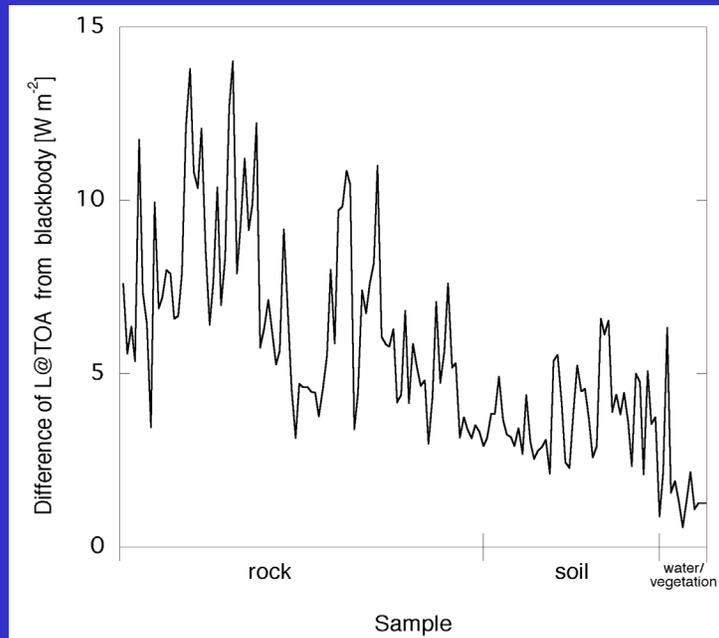
Flux Difference due to Emissivity

Figure 9: Difference in NLW Flux (Wm^{-2}) : Flux with variable variable ϵ - flux with constant ϵ

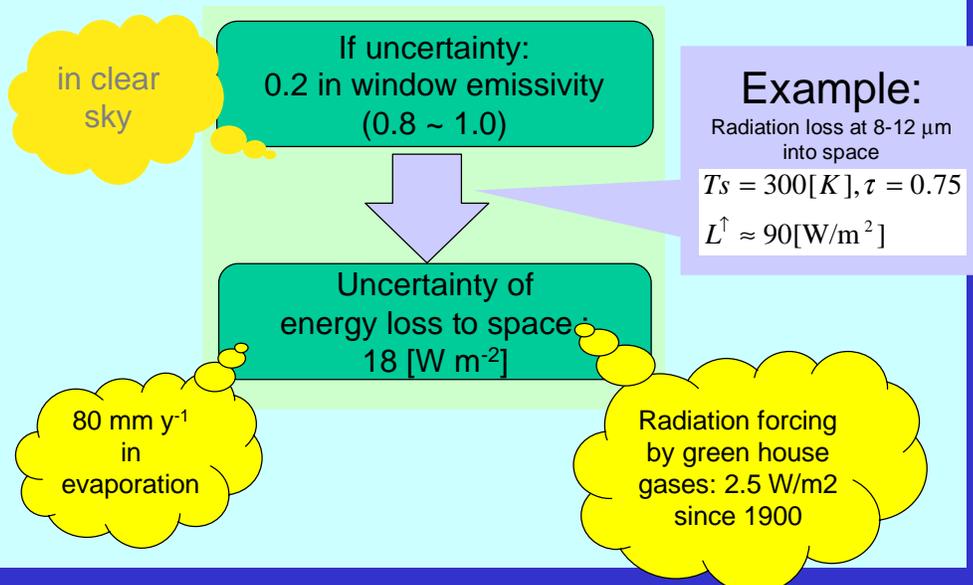


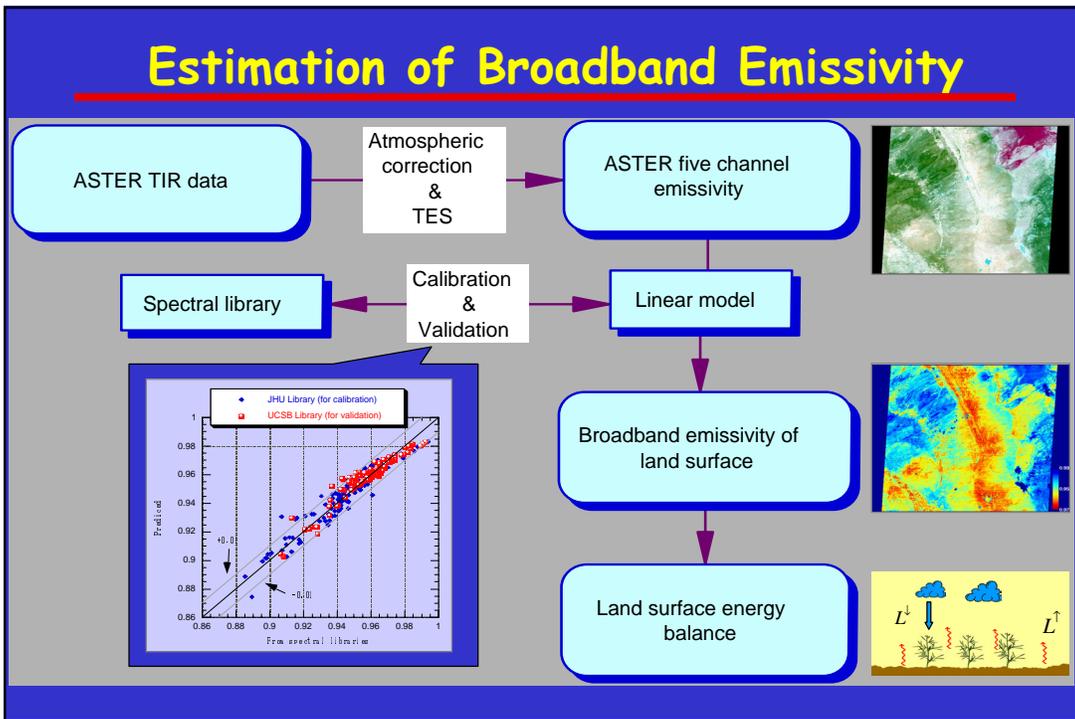
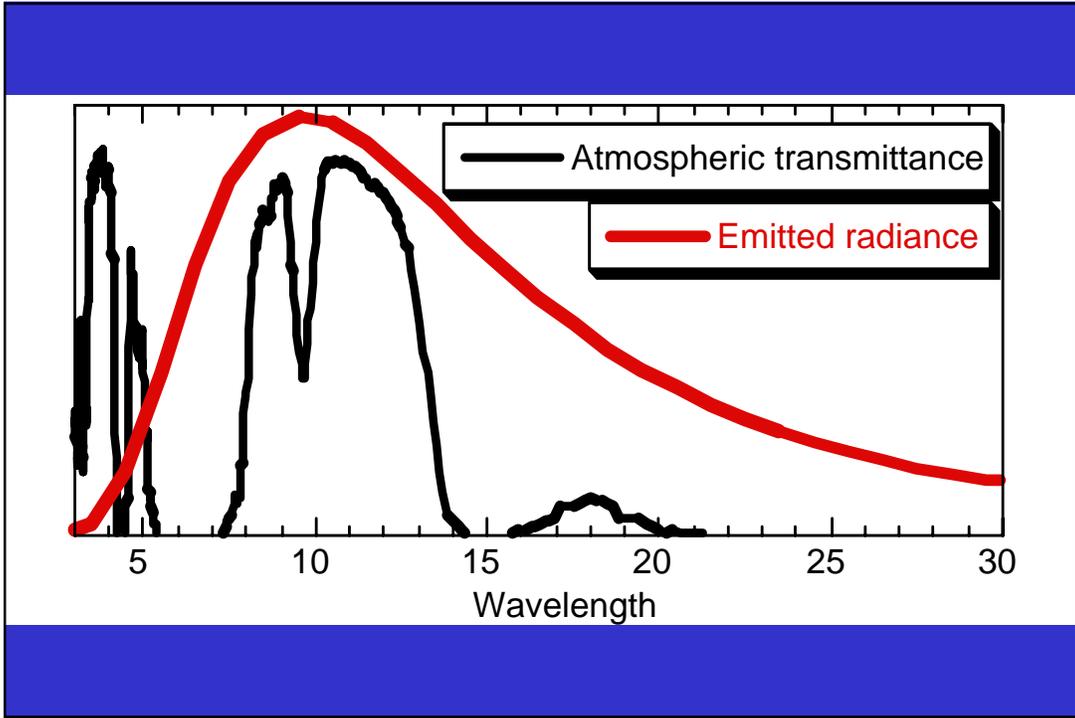
From Wilber et al., 1999 NASA TP-1999-209362

Calculation of NLW for 150 Emissivity Spectra

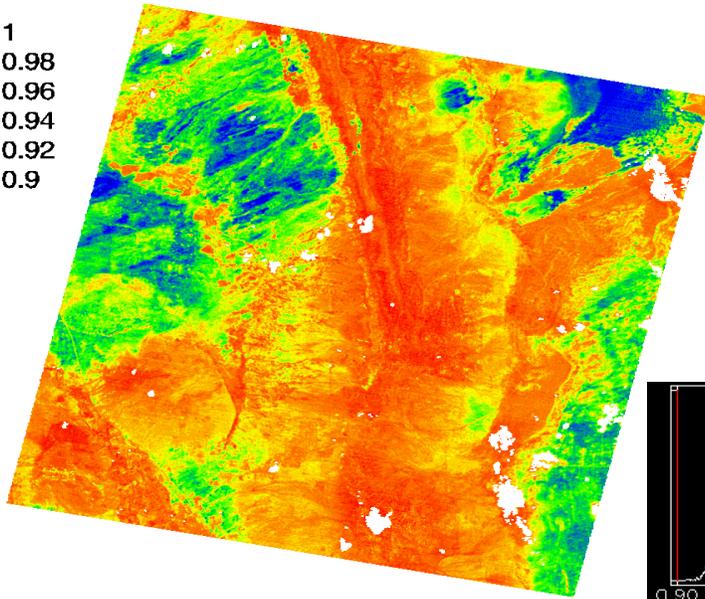
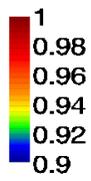


Effect of uncertainty in emissivity

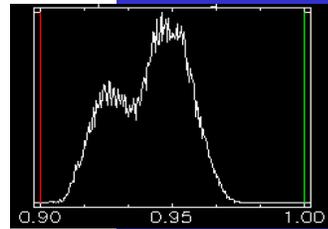




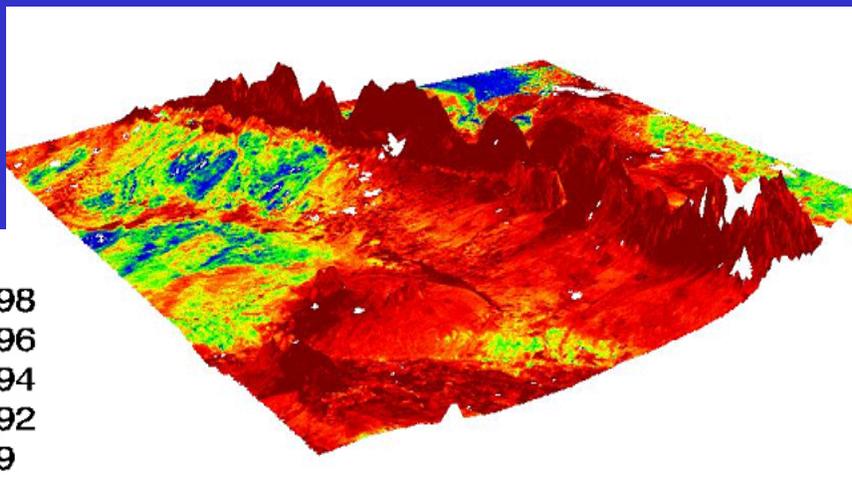
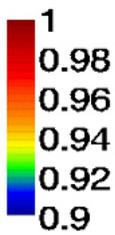
Window (8-12 μ m) Emissivity from ASTER



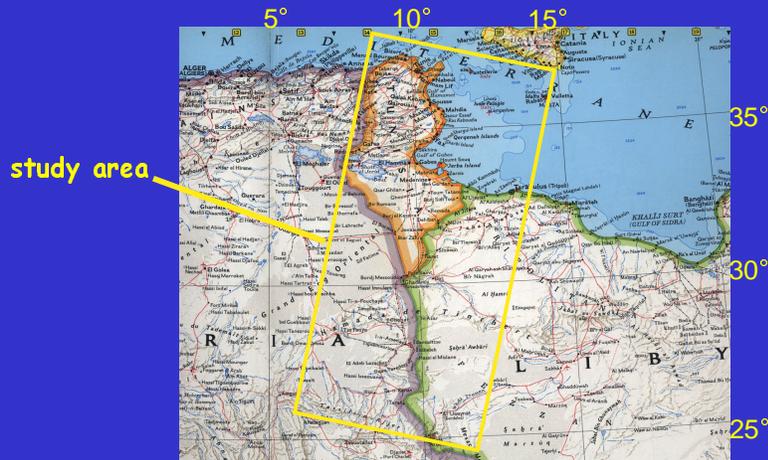
Jornada
LTER Site
May 12, 2001



Emissivity Draped over DEM

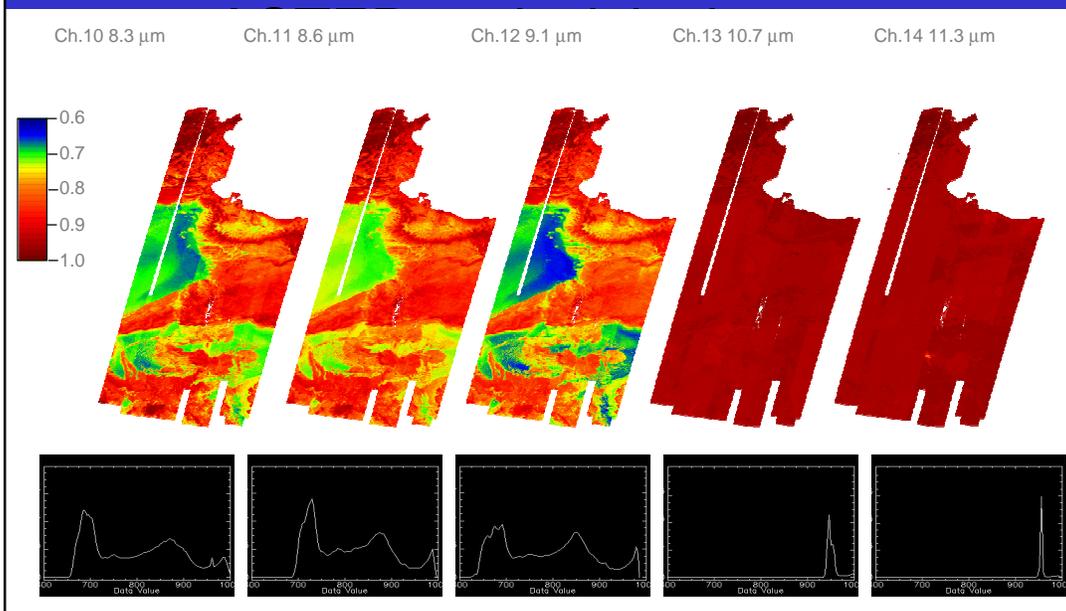


Study area: Sahara Desert in North Africa

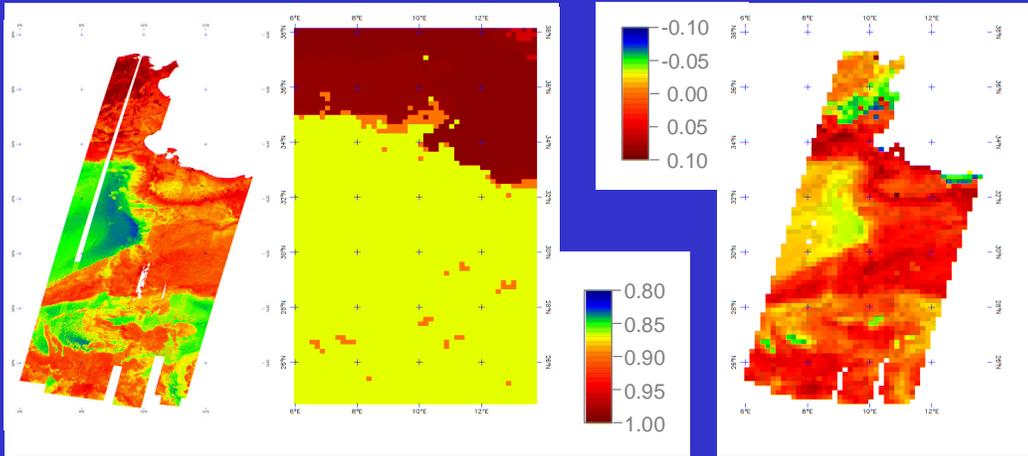


- 200 scenes of ASTER data acquired from 2000 to 2002
- Size of area 400 x 1500 km

Emissivity of ASTER channels



Comparison of Emissivity (8-12 μ m) Maps

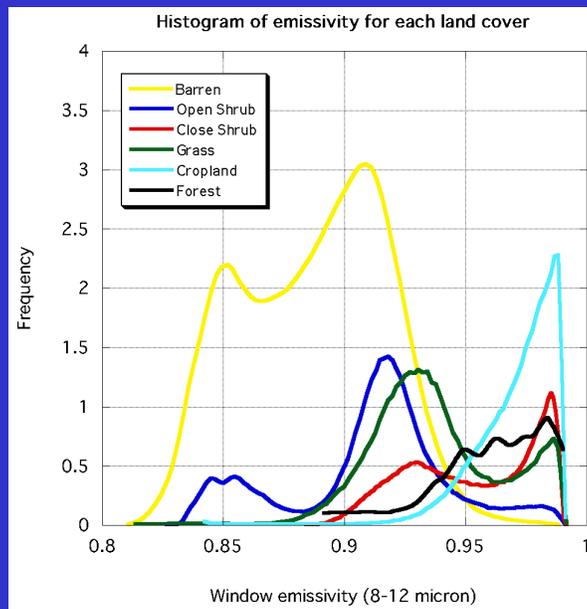


(A)
From ASTER data

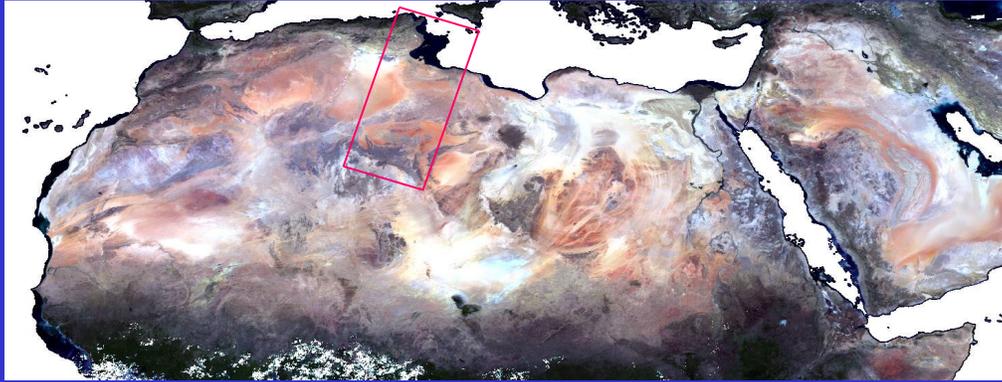
(B)
Based on IGBP land use
from *Wilber et al. (1999)*

The difference of two maps:
(A)-(B)

ASTER Emissivity Dependence on Land Type



MODIS Nadir Adjusted Reflectivity Monthly Composite - 0.05°



Emissivity Estimated from MODIS Reflectivity Window emissivity of North Africa

